SPECIFICATION

METHOD FOR PRODUCING COMPOSITE METAL PRODUCT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for producing a composite metal product comprising a carbon nano material and a metal material by injection molding.

2. Description of the Related Art

A carbon nano material, which is a kind of crystalline carbon materials, has such characteristics that its heat conductivity is five times or more as high as that of aluminum (Al), magnesium (Mg) and the like, it is excellent in electric conductivity, and it is also excellent in slidability because it has a low friction factor. Since the carbon nano material is very minute, however, it is said that the material is preferably used by being composited with other material.

In a conventional method, a composite material is obtained by mixing the carbon nano material and metal powder, pressing and pulverizing said mixture so that the the particle size is from 5 μm to 1 nm, and a composite product is obtained by hot pressing said pulverized mixture. The aboveconventional method has a problem in that metal products of electronic equipment such as heat sinks, shields and bearings, and the like are difficult to be molded by a hot press from a composite material containing the crystalline carbon material.

SUMMARY OF THE INVENTION

An object of the present invention, which has been devised to solve the above problems of the prior art, is to provide a novel compositing and molding method for enabling a

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carbon nano material to be composited with a metal material by injection molding and applying the characteristics of the carbon nano material to a metal product without being limited by the size and shape of the metal product so that functions required to the parts of electronic equipment such as high heat conductivity, excellent electric conductivity, excellent slidability, and the like can be improved, and to provide a composite metal product.

A method for producing a composite metal product containing a carbon nano material and a metal material of the present invention for achieving the above object comprises the steps of; mixing a carbon nano material with a metal material in a powder state; compressing a resultant mixed material to a solid material by a hot press and forming said solid mixed material into granules such as chips, pelletes, and the like; melting the metal thereof and kneading the granules to form a composite material and injecting and the composite material into a mold to form the composite metal product; and obtaining a composite metal product containing the carbon nano material and the metal material. The metal material is preferably a low melting point metal. The above melting and kneading step and the injecting step may be performed by using an inline screw type injection machine or a screw type preplasticization injection machine. Further, the object of the present invention is achieved by a composite metal product obtained by any one of the above methods.

According to the above arrangement, since the carbon nano material and the metal material are formed to the granules which are used as a molding material, a material used in a compositing and molding process can be easily supplied. Further, since the metal material can be effectively melted and the carbon nano material and the metal material can be blended in a short time, a composite metal product having uniform quality can be obtained. Further, since molding the

composite metal product is achieved by injection molding, the composite metal product has a high molded accuracy and the product is not limited in its shape and size different from a product formed by a press. Therefore, it is possible to easily produce a composite metal product having functions of high heat conductivity, excellent electric conductivity, low friction factor, and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a process view of a method of producing a composite metal product cpmprising a carbon nano material and a low melting point metal according to the present invention; and

FIG. 2 is a schematic sectional view of a screw type preplasticization injection machine for use in the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, powder of a carbon nano material 1, which is known as a carbon nano tube and the like, and powder of a low melting point metal material 2, which is composed of at least one selected from the group consisting of metals, alloys of magnesium (Mg), tin (Sn), aluminum (Al), copper (Cu), lead (Pb), and zinc (Zn), are charged into a mixer 3 and stirred and mixed therein as shown in FIG. 1. A conventional mixer for a powder may be used for the mixer 3 and an example of the metals used herein is a magnesium-base alloy of a low melting point metal. It is preferable that they be mixed in an inert gas astmosphere. There is a carbon nano tube having a diameter of 10 nm (0.01 μm) and a length of 1 to 10 μm as a commercially available carbon nano tube.

Next, the mixed material 4 is transferred to a hot press 5 and heated and compressed so that it is molded to a sheet-shaped solid material 6. An example of the compession molding

conditions is such that a carbon nano tube is added in an amount less than 30 vol% without an addition of a binder, a compression temperature is about 500°C, and a compression pressure is about 30 MPa. The solid material 6 molded by the compression molding is processed to granules 7 such as pellets, chips, and the like by known means such as cutting, pulverizing, grinding or crushing, and the granules 7 are as a molding material supplied to an injection machine, which has an injection device 8 having heating means around the outer periphery thereof and a mold 9 for a product.

The injection machine 8 has an injection screw 83 with a check valve disposed in a heating cylinder 82 having a nozzle 81 at the head thereof, the injection screw 83 rotating and moving forward and rearward in the heating cylinder 82. Further, a hopper 84 is mounted on a supply port formed on the heating cylinder 82 at a rear portion thereof. The granules 7 are supplied from the hopper 84 into the heating cylinder 82 , where the low melting point metal is melted, are blended by the rotation of the injection screw 83 and formed a composite material and this composite material is fed to the head of the screw 83 under pressure. Then, after the composite material is weighed (stored) in the head portion of the heating cylinder 82 in a molten state of the metal when the screw is moved rearward by internal pressure, they are injected into and fill the mold 9 for a product as a molding material as the screw moves forward. Note that it is preferable that the inside space of the heating cylinder 82 be filled with an inert gas atmosphere to prevent oxidation.

The mold 9 is composed of a pair of open/close divided molds 93 attached to a stationary platen 91 and a movable platen 92 of a mold clamping unit (not shown) and has cavities 94 for forming two sets of products in the interior thereof and a sprue 95 which is located at the center of both the cavities 94 and against which a nozzle 81 is abutted. The

composite material injected from the nozzle 81 fills both the cavities 94 from the sprue 95, thereby composite metal products 10, in which the carbon nano material 1 is uniformly composited with the metal material 2, are formed.

Although the above embodiment employs the inline screw type injection machine 8 and the metal material in the granules 7 is melted and blended with the carbon nano material by the injection screw 83 and thus obtained composite material is injected into and fill the mold 9, the above operation can be effectively executed by employing a screw type preplasticization injection machine that is used to mold a resin.

As shown in FIG. 2, a screw type preplasticization injection machine ordinarily constructed includes a melting/kneading device 14 and an injection device 17 disposed in parallel with each other, and a flow path 18 having an open/close valve 19 is disposed between the head of the melting/kneading device 14 and the injection device 17 so that the melting/kneading device 14 communicates with the injection device 17 through the flow path 18. The melting/kneading device 14 has a melting/kneading cylinder 11 having a melting/kneading screw 12 disposed therein and a hopper 13 disposed on the cylinder 11 at a rear portion thereof, and the injection device 17 has an injection cylinder 15 including an injection plunger 16 forward and rearward movably disposed therein.

Accordingly, in the molding process, the granules are melted, wherein the metal is melted, and blended by the melting/kneading device 14, thereby a composite material is formed, then thus obtained composite material is fed to the front portion of the injection cylinder 15 under pressure and weighed therein. After the composite material is weighed, the open/close valve 19 of the flow path 18 is closed. In the injection device 17, the composite material is injected from a

nozzle 20 into and fill the mold 9 as the injection cylinder 16 moves forward. In the melting/kneading device 14, the metal of the granules 7 supplied thereto begin to be melted and blended while the injection and filling operation is executed in the injection device 17. Accordingly, the screw type preplasticization injection machine can more effectively mold the composite metal products 10, in which the carbon nano material 1 is uniformly composited with the metal material 2, than the inline screw type injection machine that executes both the melting/kneading operation and the injecting operation in the same machine.